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Trees and Logs Important to Wildlife in the Interior Columbia River Basin

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ABSTRACT

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This publication provides qualitative and quantitative information on five distinct structures: living trees with decayed parts, trees with hollow chambers, trees with brooms, dead trees, and logs. Information is provided on the value of these structures to wildlife, the decay or infection processes involved in the formation of these structures, and the principles to consider for selecting the best structures to retain.

Keywords: Broom rust, cavity nesters, decay fungi, dwarf mistletoe, Elytroderma, forest management, habitat monitoring, hollow trees, interior Columbia River basin, logs, old-growth forests, snags, wildlife, wood decay.

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INTRODUCTION



More than 80 species of birds, mammals, reptiles, and amphibians use living trees with decay, trees with brooms, hollow trees, snags, and logs in the interior Columbia River basin. Animals use these structures for foraging, nesting, denning, roosting, and resting. Most notable of these wood-using wildlife species are the primary cavity nesters, the woodpeckers and nuthatches, that excavate nest cavities in decayed wood in standing trees. Their vacated cavities are subsequently used by many other birds and mammals. About 25 percent of the bird species nesting in the northern Rocky Mountain forests are cavity nesters (McClelland and others 1979). Many of the primary and secondary cavity-nesting birds eat forest insects and thus play an important role in regulating their populations. Machmer and Steeger (1995) provide a thorough review of the effect these birds have in reducing numbers of tree-feeding insects.

Tree decay is an important ecological process affecting wildlife habitat. Once begun, the decay process can take hundreds of years as a tree dies, falls to the ground, and decomposes into the forest floor. As it decays, the tree supports many different wildlife groups that use it for foraging substrate, for nesting, and for shelter. The group of wood decomposers is diverse. It includes many arthropods, but in this publication, we focus on decay fungi as the primary organisms in decay. Decay fungi are an essential resource to forest ecosystems in storing and retaining nutrients and in soil development.

This publication provides managers with a description of the ecological processes that create wildlife trees, snags, and logs. It provides qualitative and quantitative information on five distinct structures: living trees with decay (such as internal decay), hollow trees, trees with brooms (misshapen branches), dead trees (snags), and down woody material (logs). We describe the value of these structures to wildlife, the decay or infection processes that produce each type of structure, principles to help in selecting the best structures to retain, and management implications. Although this document cannot prescribe the amount of landscape to manage

for a particular species or a specific, desired population size, it does present information managers can use to make informed decisions regarding the conservation and enhancement of dead wood structures most valuable to wildlife. Forest management practices that fail to properly manage wood components may adversely affect wildlife, soil and stream quality, and forest ecosystem functions.

The information included here applies to coniferous forest lands in the interior Columbia River basin: the area east of the crest of the Cascade Range in Oregon and Washington, all of Idaho, and a portion of western Montana (fig. 1). Tree species characteristic of high-elevation forests, (such as whitebark pine [*Pinus albicaulis*], alpine larch [*Larix lyallii*], mountain hemlock [*Tsuga mertensiana*], and Pacific silver fir [*Abies amabilis*]) are excluded because they typically grow where active management for wildlife trees is seldom needed; these areas are seldom logged. Most of the tree species we deal with here are conifers, although black cottonwood (*Populus trichocarpa*), quaking aspen (*Populus tremuloides*), and paper birch (*Betula papyrifera*) are



Figure 1—The interior Columbia River basin.

included because they commonly occur in managed conifer forests.

Additional information on how to distinguish among different species of snags and logs is provided in a companion document (Parks and others, in press) specifically designed to be used in the field.



LIVING TREES WITH DECAY



Ecological Processes and Functions

Although dead, standing trees (snags) are important to many wildlife species, living trees may contain decayed wood that allows them to function as snags. Living trees with an internal core or pockets of decay, top dieback, broken tops, or wounds all can serve as wildlife habitat (fig. 2). Living trees with dead portions typically stand longer than snags do, but the portion of the tree suitable for use by snag-dependent wildlife may be smaller than in a snag of the same size. Although hollow trees are alive, but with advanced internal decay, we treat them separately because they offer unique structural features and provide for specialized wildlife use.

Some woodpeckers select living trees with decayed heartwood because they can penetrate through the sound layer of sapwood and excavate the nest chamber in the softened heartwood (fig. 3) (McClelland and others 1979, Parks and others 1996a). Typically, the sapwood remains relatively intact for a long time, forming a shell surrounding the decaying heartwood, so the excavated interior may retain a desirable shape for nesting for many years. Woodpeckers commonly nesting in decayed wood in living trees in northeastern Oregon

include the Williamson's (*Sphyrapicus thyroideus*) and red-naped sapsuckers (*S. nuchalis*) and black-backed woodpeckers (*Picoides arcticus*) (Bull 1986). Living trees with heart rot are a required habitat component for the red-cockaded woodpecker (*P. borealis*), a widely known and rare species from the Southern United States. This woodpecker selects pines older than 80 years that are infected with the heart-rot fungus *Phellinus pini* to excavate its cavities (Conner and Locke 1982, Hooper and others 1991).

Trees with large dead branches or dead tops (fig. 4) provide a distinctive habitat in the living forest canopy (Parks and Shaw 1996). Cavity nesters such as the white-headed woodpeckers (*Picoides albolarvatus*) commonly roost in dead tops of living trees (Dixon 1995). Dead tops provide good resonating towers from which drumming woodpeckers proclaim their territorial boundaries and provide hunting perches for raptors. Living trees with broken tops also may provide nesting platforms for raptors.

Any wounding or scarring of the living tree can result in localized dead, decaying wood (fig. 5). Decaying wood, particularly at the base of the living tree, is often colonized by ants. Pileated woodpeckers (*Dryocopus pileatus*) forage



Figure 3—Longitudinal section of a nest cavity excavated in a lodgepole pine by a black-backed woodpecker. Heartwood is softened by heart-rot fungi.

Figure 2—Woodpecker nest cavities are often in broken-topped living trees that contain decayed wood near the break.



Figure 4—Woodpecker nest cavity excavated in the dead top of a living ponderosa pine.



Figure 5—Scars caused by lightning or other injuries are frequently used by woodpeckers for foraging.

on ants at these sites, as documented in a study that found 18 percent of foraging by these birds is in living trees (Bull and Holthausen 1993).

Decay Process

Wood decay is caused by fungi that decompose the cell wall. Wood decayers can be separated based on whether a fungus survives primarily in the heartwood of living trees or primarily in dead trees or in logs. Generally, the decay fungi in upper stems of living trees are heart-rot fungi (Manion 1981). The decay fungi of dead trees and logs are saprophytic fungi. Although every tree species is susceptible to at least one heart-rot fungus, few fungi can cause heart-rot in living trees. Conversely, many decay fungi can survive on dead branches of living trees, or inhabit a tree once it dies.

Heart-rot fungi are spread by airborne spores produced by fruiting bodies—either conks or mushrooms. The spores colonize freshly exposed wood at wounds or dead branch stubs. Although spores of heart-rot fungi are abundant in forest stands of all ages, old-growth stands have a much higher incidence of heart rot than do young stands (Manion 1981). The amount of heartwood is age related; older trees have a higher ratio of heartwood to sapwood than do younger trees (Gartner 1995). Decay in the heartwood may continue to increase in diameter as the trees grow and new layers of heartwood are added (Rayner and Boddy 1988).

Internal decay—Every living tree is composed of tissues that perform specific functions; decay in stems of living trees is closely linked to wood anatomy (fig. 6). The sapwood and heartwood offer different microhabitats and nutritional substrates for decomposer organisms. Typical heartwood has no living cells, is nonconductive, and develops in the oldest wood; sapwood has some living cells, is conductive, and occupies the outer sheath of wood around the stem, or the entire wood cylinder of a younger tree (Sperry 1995). In contrast to dead sapwood, which decays readily, live sapwood generally is resistant to decay partly because of its high moisture content and reduced aeration. Live sapwood may remain free of infection for many years, even when neighboring sapwood or heartwood is extensively decayed (Shain 1995).

The decay process of dead tops and other dead wood in the living tree, typically associated with dieback or wounding, is the same as in dead trees, described later in this report.

Selecting Trees

Decay in living trees is not always apparent, but certain characteristics can indicate its presence. Conks (fungal fruiting bodies) are evidence of heartwood decay, although fruiting bodies may not always be present in trees decayed by heart-rot fungi. Some fungi tend to fruit only on fallen or cut trees and produce fruiting bodies on living trees only rarely. Generally, fruiting bodies of heart-rot fungi are found close to branch stubs or living branches and are few compared to the numbers of fruiting bodies of sapwood-decaying or saprophytic fungi, which may be found in groups over the whole stem surface of dead trees and logs.

Most tree species are susceptible to only a few heart-rot fungi. Ponderosa pine (*Pinus ponderosa*) is commonly associated with red ring rot caused by *Phellinus pini* (fig. 7). This fungus also may be found fruiting on lodgepole pine (*Pinus contorta*), western white pine (*P. monticola*), western larch (*Larix occidentalis*), and Douglas-fir (*Pseudotsuga menziesii*) in some areas. Internal decay in grand fir (*Abies grandis*), subalpine fir (*A. lasiocarpa*), and mountain hemlock often is indicated by conks of the Indian paint fungus (*Echinodontium tinctorium*) (figs. 8 and 9). Indian paint fungus causes a characteristic stringy decay that can involve the entire tree trunk (fig. 10). Internal decay of western larch and occasionally ponderosa pine is indicated by the fruiting body of the brown trunk rot caused by *Fomitopsis officinalis* (fig. 11). Internal decay in quaking aspen and paper birch is most often associated with *Phellinus tremulae* (fig. 12) and *P. igniarius*, respectively. Depending on climate, elevation, and other local conditions, fruiting bodies may be occasional or abundant. Hepting (1971) provides a complete list of the decay fungi associated with forest trees in the United States.

In the absence of fruiting bodies, obvious wounds are the next best indicators of internal decay in living trees. Wounding is fundamental to decay because germinating fungal spores cannot penetrate intact bark or living sapwood. Spores usually must land on exposed dead wood directly connected with the heartwood for decay to result (Boyce 1938). Broken tops, fire or lightning scars, or mechanical damage from harvest activities all may be good indicators of incipient or advanced internal decay. Sixty-two percent of 133 woodpecker nests in living trees had broken tops, and 17 percent had dead tops (McClelland and others 1979). All nests were associated with internal decay. Forty-four percent of the paper birch and 22 percent of the quaking aspen with nest cavities had fruiting bodies (McClelland 1977).

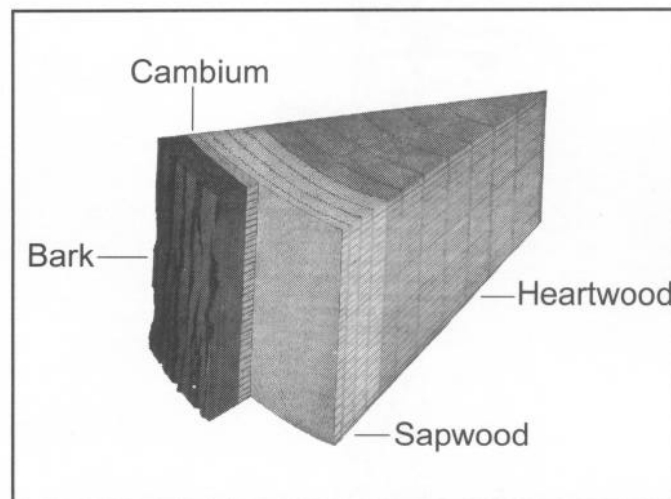


Figure 6—Wood anatomy showing the relation of sapwood and heartwood, each of which provides specialized substrates used by different micro-organisms (modified from Brown and others 1949).

Review

- A living tree may contain decayed wood that provides special wildlife use.
- Dead tops, large dead branches, broken tops, and wounded areas provide useful habitat in living trees.
- Living trees containing a decayed column of heartwood may stand longer than dead trees and can provide habitat for cavity nesters.
- Fungi that are specialized decomposers and decay the heartwood of living trees are heart-rot fungi. Fungi that are generalist decomposers are usually found only on dead parts of trees, snags, or logs and are saprophytic fungi.
- Conks indicate decay within the tree. Heart-rot fungi can be distinguished from saprophytic fungi by the appearance of their conks. In the absence of conks, broken tops, wounds, and scars also are indicators of decay in living trees.

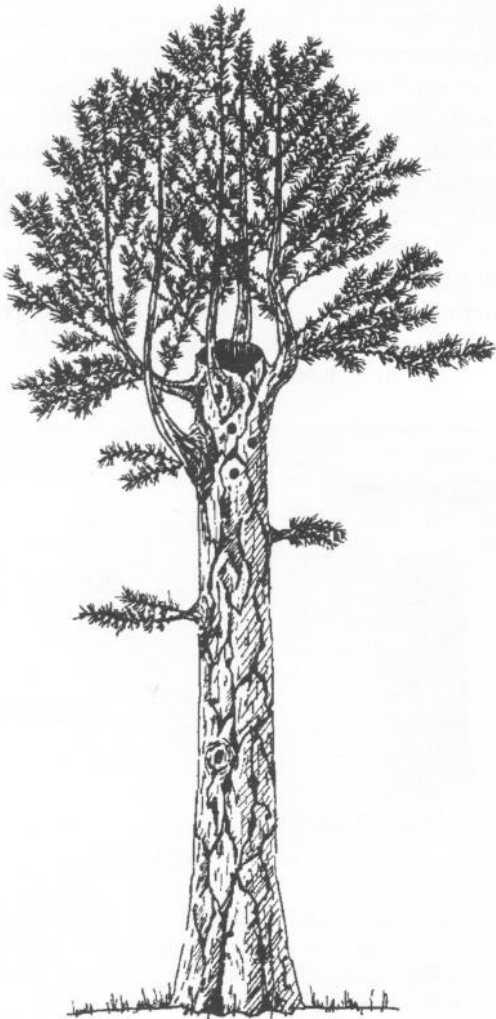


Figure 7—Fruiting bodies of red ring rot are hoof-shaped or flat on bark, dark brown on the upper surface, and cinnamon to tan on the lower surface and in the interior. This conk indicates internal decay, which is stringy with pronounced white pockets. Infected trees may have punk knots on the stem.



Figure 8—Fruiting bodies of Indian paint fungus are hoof-shaped and commonly located under a branch or branch stub.



Figure 9—Conks of Indian paint fungus have a brown woody upper surface with teeth projecting downward on the lower surface. The interior is orange.



Figure 10—The decay caused by Indian paint fungus is restricted to the heartwood of the tree, and older trees often become hollow. Advanced decay is stringy and reddish brown to yellow.

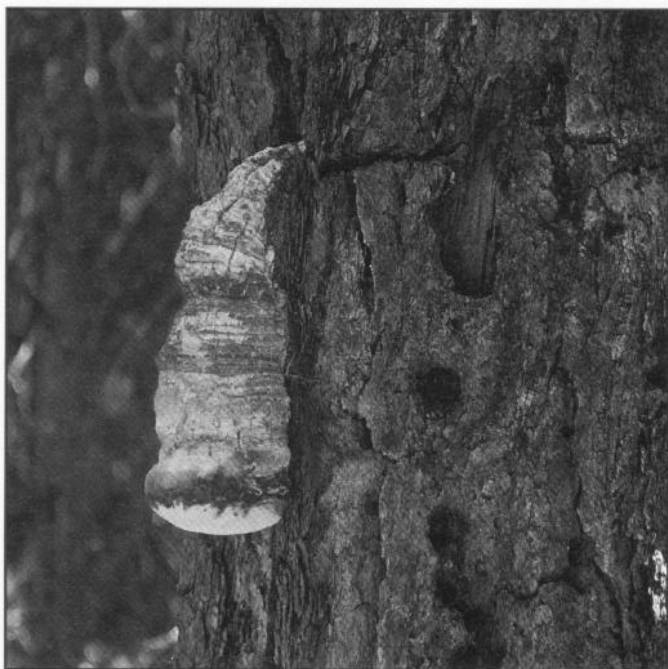


Figure 11—Fruiting bodies of brown trunk rot are hoof-shaped or cylindric with a chalky consistency. The upper surface is yellow, white, or cream, and the under surface is yellow or white with a pored texture. The fungus causes a brown cubical decay. White felts may be found in shrinkage cracks of decayed wood.

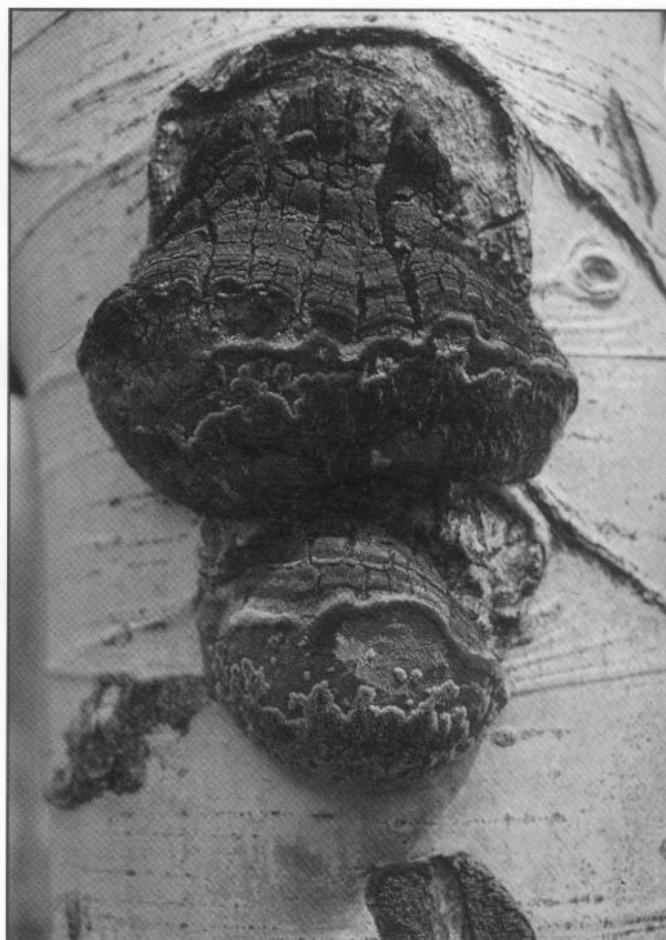
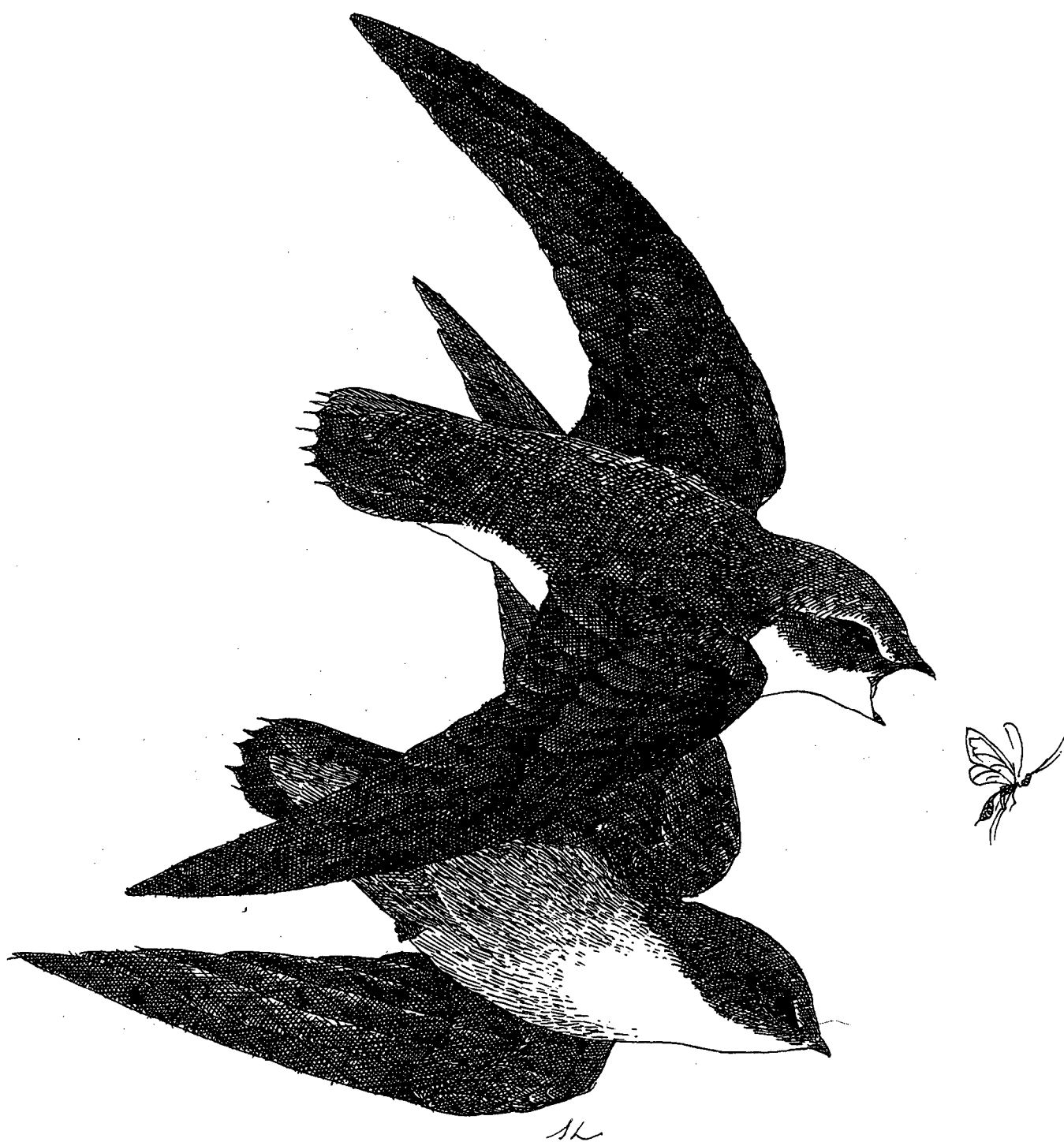
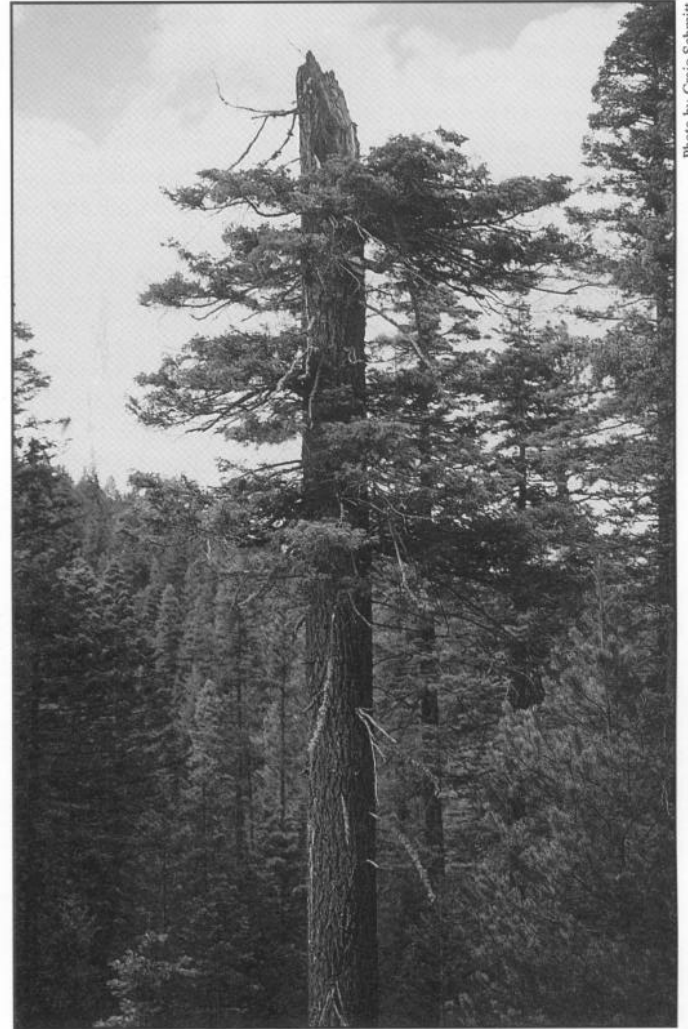


Figure 12—Fruiting body of *Phellinus tremulae* on quaking aspen.





HOLLOW TREES

Ecological Processes and Functions

We define a hollow tree as a tree having decay in the heartwood so advanced that it leaves a hollow core. Large-diameter trees, those more than 20 inches in diameter at breast height (d.b.h.), form hollow chambers most useful to wildlife.

The importance of hollow trees to wildlife has only recently been recognized. Hollow trees with broken tops are used by black bears (*Ursus americanus*) for den sites (Akenson and Henjum 1994, Hamilton and Marchinton 1980, Noble and others 1990, Parks 1996a). These arboreal dens provide females and subadults with sites that are safe from predaceous, large, male bears. Hollow chambers at the bases of some trees also are used as den sites (fig. 13).

Pileated woodpeckers use hollow trees for roosting at night (Bull and others 1992); they excavate their own entrance holes to the hollow chambers and do not depend on broken tops for access. Entrance holes excavated by the woodpeckers allow other species to enter, such as flying squirrels (*Glaucomys sabrinus*), bushy-tailed woodrats (*Neotoma cinerea*) (fig. 14), bats (Nagorsen and Brigham

1993), American martens (*Martes americana*), northern flickers (*Colaptes auratus*), and Vaux's swifts (*Chaetura vauxi*).

Martens frequently use hollow trees for denning, as well as for resting and hunting (Bull 1995) (fig. 15). Use of such trees provides dry rest sites during inclement weather. Vaux's swifts must have hollow trees for both nesting and roosting in forests (Bull and Collins 1993) (fig. 16). Swifts readily enter these trees, either through an open top or through an entrance hole excavated by a pileated woodpecker.

Decay Process

A hollow tree is created when heart-rot fungi invade the heartwood of a living tree, and decay progresses to the point that the cylinder of decayed heartwood eventually detaches from the sapwood and slumps downward, leaving a hollow chamber. This process begins only in a living tree and can take many decades to produce a chamber large enough for wildlife to use. Because this particular decay process is dependent on living trees, the only way to obtain a hollow dead tree or log is to start with a living tree hollowed out by decay.

Heart-rot fungi do not typically kill trees, but trees with advanced heart rot often have broken tops because the hollow interior weakens the bole. Because the trees are living, a bayonet top may form where new leaders grow around and over the broken top forming an umbrella of foliage (figs. 17 and 18). Hollow trees provide valuable wildlife habitat for decades before they eventually die and become hollow **snags** (fig. 19) or fall over as hollow logs (fig. 20).

Selecting Hollow Trees

No artificial means to create or encourage the formation of a hollow tree structure has been found, so retaining such trees in managed stands is essential to providing habitat for the species that depend on them. Large-diameter trees that show some evidence of being hollow are of the greatest value. In the absence of apparently hollow trees, large trees of the species most commonly producing this structural feature, such as grand fir and western larch, should be conserved.

A large-diameter tree is vital because the chamber typically consists only of the former heartwood. To be most useful, the chamber must be large enough for a swift to fly up and down, for a pileated woodpecker to enter; or for a bear to occupy. All of these wildlife species typically use entrances from 30 to 80 feet off the ground, where the heartwood cylinder needs to be large enough to provide a chamber of suitable size. The average size of 21 trees used by swifts for nesting was 27 inches d.b.h. and 85 feet in height in northeastern Oregon (Bull and Collins 1993). Bear dens in hollow trees with top entries averaged over 43 inches d.b.h. and 57 feet tall in northeastern Oregon (Akenson and Henjum 1994). Pileated woodpeckers roosted in hollow trees that averaged 28 inches d.b.h. and 74 feet tall in northeastern Oregon (Bull and others 1992).

Evidence that large-diameter trees have hollow interiors includes the following:

- A broken bole with a bayonet top formed over the break (figs. 17 and 18)
- More than one pileated woodpecker entrance hole
- Fruiting bodies of Indian paint fungus (fig. 8)
- An old injury or bend along the bole where a new leader formed a new trunk many years ago.

In northeastern Oregon, grand fir and western larch make up most of the hollow trees used by wildlife. All 56 nest and roost trees used by swifts were grand fir (Bull 1996a). Sixty-one percent of 123 pileated woodpecker roost trees (Bull and others 1992), and 8 of 10 arboreal bear dens were in grand fir as well (Akenson and Henjum 1994). The remainder of hollow trees used by pileated woodpeckers or black bears were primarily western larch and a few ponderosa pine. We suspect hollow chambers may be common in old western redcedar (*Tsuga plicata*) in the interior Columbia River basin, because hollows caused by heart rot in old western redcedar trees are used by pileated woodpeckers for roosting in western Washington (Parks and others 1997) and in the

Oregon Coast Range (Mellen 1987).

Although lodgepole pine, Douglas-fir, subalpine fir, Engelmann spruce (*Picea engelmannii*), and western white pine are subject to heart rot, they seldom form a hollow chamber. These species should not be retained with the expectation that they might produce hollow trees.

Information on the number of hollow trees to retain for wildlife use is limited. Bull and others (1992) suggest leaving 44 grand fir roost trees (0.07 per acre) known to be hollow or 880 grand fir trees (1.47 per acre) suspected of being hollow in each 600-acre pileated woodpecker management area to provide trees for roosting. No models have been developed to predict the portion of hollow stem, based on the presence of conks alone, in large-diameter, living grand fir.

Large, hollow trees are uncommon in managed landscapes and typically are found only in late- and old-seral stands of grand fir and western redcedar. Although isolated hollow trees in young stands have significant value to wildlife, these young stands cannot reproduce this type of structure for at least 150 to 200 years. The late-seral, multilayer stands that produce hollow trees comprise less than 3 percent of the forested landscape in the interior Columbia River basin (Hann and others, in press). Retaining all hollow trees in managed landscapes can be justified in most areas because so little of the landscape has them, they have little commercial value, and they are of great value to wildlife. Rarely, where large blocks (in excess of 600 acres) of this habitat have many hollow trees (in excess of 10 per acre), does the number of hollow trees probably exceed the wildlife need for habitat.

Review

- A hollow tree is created by heart-rot fungi. This kind of decay initiates only in a living tree.
- Evidence that a tree has a hollow interior includes a broken bole with a bayonet top, more than one pileated woodpecker cavity, fruiting bodies of Indian paint fungus, or an old injury or bend along the bole where a new leader formed a new trunk many years ago.
- Hollow trees are known to be used by pileated woodpeckers, northern flickers, Vaux's swifts, American martens, flying squirrels, black bears, bats, bushy-tailed woodrats, and other small mammals as dens, roosts, nests, forage sites, and shelter.
- Large-diameter hollow trees provide the best wildlife habitat; the mean d.b.h. of hollow trees used by black bears was 43 inches; by pileated woodpeckers, 28 inches; and by Vaux's swifts, 27 inches.
- Tree species that most commonly form hollow interiors are grand fir, western larch, and western redcedar.
- Retaining all hollow trees in managed landscapes can be justified in most areas because these trees are uncommon, occur on less than 3 percent of the landscape, have little commercial value, and have great wildlife value.



Photo by David Carroll

Figure 13—Black bear sow and cub in a winter den in the base of a living grand fir.



Figure 14—Entrance holes are excavated by pileated woodpeckers into hollow trees, allowing access by bushy-tailed woodrats and other wildlife.



Figure 15—American martens use hollow trees for denning and shelter.



Figure 16—Vaux's swifts both nest and roost in hollow trees.



Figure 17—Broken tops are common in hollow living trees. One or more bayonet tops often form over the break.

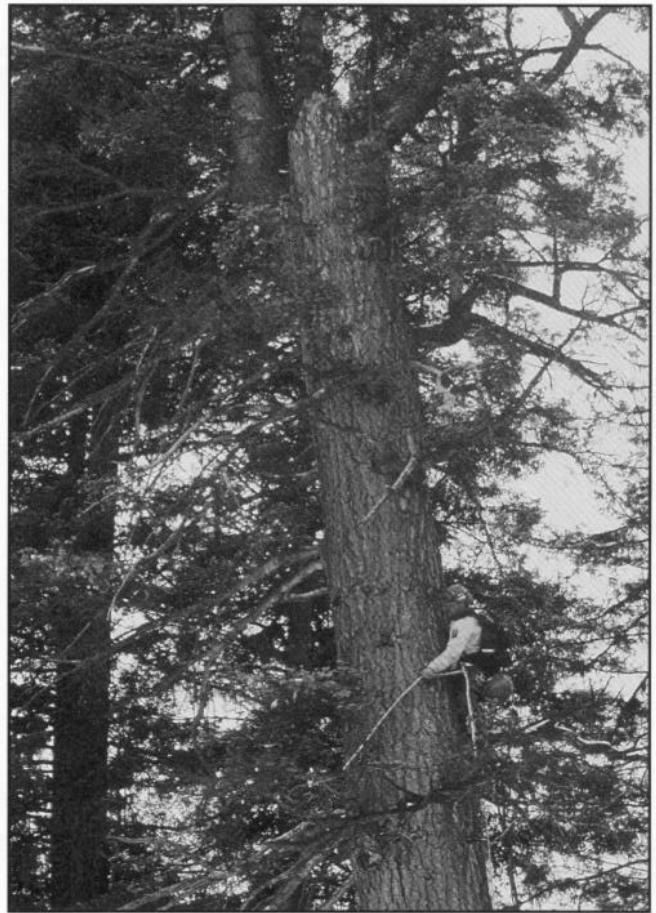


Figure 18—A 350-year-old hollow grand fir used as an arboreal den site by black bears. The bayonet top is more than 80 years old.



Figure 20—Hollow logs originate only from living trees that were colonized by heart-rot fungi.

Figure 19—Hollow dead trees originate only from living trees in which the heartwood chamber has been decayed by heart-rot fungi.